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SOME PHILOSOPHICAL PROBLEMS OF CYBERNETICS

by V. B. Borshchev,
F. Z. Rokhlin and V. V. Ul'in

-USSR-

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FOREWORD

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SOME PHILOSOPHICAL PROBLEMS OF CYBERNETICS

-USSR-

[Following are the translations of two articles from
Nauchnyye doklady vysshey shkoly, Filosofiskiye nauki
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ON M. N. ANDRYUSHCHENKO'S ARTICLE "SOME PHILOSOPHICAL
PROBLEMS OF CYBERNETICS"

[Following is the translation of an article by V. B. Borshchev, F. Z. Rokhlin, and V. V. Ul'in in Nauchnyye doklady vysshey shkoly, Filosofskiye nauki, (Scientific Reports of the Higher School Philosophical Sciences), No 4, Moscow, 1960, pages 106-108.]

Cybernetics is more and more attracting the attention of philosophers. It is gratifying that the periodical Filosofskiye Nauki (Philosophical Sciences) has joined in the discussion of the philosophical problems of cybernetics. M. N. Andryushchenko's article, "Some Philosophical Problems of Cybernetics," unquestionably arouses one's interest. One cannot but agree with the assertion of the author, namely that philosophy will have to show how far the analogy between the machine and man goes. It is evident that this problem is of fundamental importance. As the author observes, an erroneous solution "can push an engineering idea along an erroneous path ..." (Filosofskiye Nauki, No 3, 1959, page 102).

But a number of statements in the article evoke objections. The author writes: "The question, can a machine think or possess consciousness, even in theory, is not debatable. It is more a question of whether there is an ideal as a property of the brain, i.e., as a property of highly organized matter, or can this property be inherent also in the lower forms of material motion such as the physical. Holding to the positions of dialectical materialism, one can only answer negatively to this question. However, we may have complicated the construction of a machine, we remain in the confines of inorganic nature, and deal with the processes of physical and chemical nature, the function of which cannot be a psychic, ideal (concept), being a product of processes of a qualitatively different nature" (Ibid, page 100).

First of all, one cannot agree that the question of whether a machine can think is not debatable. It is especially in the resolution of this question that the various points of view such as ours and those of foreign scientists clash most violently.

Secondly, the author asserts that, from the position of dialectical materialism, one must answer negatively to this question. Substantiating this idea the author writes, "Science has still not resolved the problem of creation of the elementary cell, which would show signs of life, by artificial means; it is even more impossible to get thinking substance through artificial means so long as creation is a product of highly organized matter and cannot be a product of the lower forms of movement of matter" (Ibid, page 103.)

It is well known that N. Weiner, U. R. Ashby and others have postulated the idea of the theoretical possibility of creating a thinking machine. This point of view was subjected to sharp criticism in our philosophical literature as being idealistic. It is well known that the idealistic resolution of the fundamental question of philosophy includes a contention about the primacy of consciousness (of the individual consciousness or spirit, of God, etc.) and the secondary nature of matter. When it is said that a machine can think, then it does not follow from this that thought can exist outside of, and independent of, matter. Will a machine, which is a material object, really think? Where is the idealism here?

The contention of a theoretical possibility of creating a thinking machine is often assessed as mechanistic. For example, it is considered as mechanistic the acknowledgement by D. Kalbertson of the possibility, in the presence of a large number of computer components, of creating a robot which would behave exactly like a man (see Aftomaty [Automatic Machines], Lenin Institute, 1956, page 142).

M. N. Andryushchenko does not directly heap abuse on the mechanistic interpretation by the authors of the above point of view, but she does consider that the lower forms of movement of matter cannot possess a consciousness and, hence, thought inasmuch as these are products of highly organized organic matter.

At first glance it is evident that to D. Kalbertson thinking is reduced to the lower forms of material motion. There is no doubt that consciousness is connected with neurophysiological process going on in the brain. However, it is not reduced to these processes. Analogously, life is perpetuated on the base of physical and chemical processes, but is not reduced to them. Life originates by quantitative change, from the complexity of organization of inorganic nature. And there is undoubtedly nothing mechanistic in the attempts by artificial means to create life, even in its simplest form, since here a new quality springs from the complexity of organization (i.e., quantitative changes) -- an organic form of movement. It is asked, why can't one say that the complexity (the quantitative changes) of organization of automatic machines cannot lead to the creation in them of this new quality analagous to thinking? Just as the artificial creation of life is not a reduction of a higher form of motion to a lower, so the origination in a machine of a quality analagous to thinking should not be understood as a reduction of consciousness to the lower forms of material motion.

Here an objection is possible, that life in natural circumstances originated from inanimate nature, but consciousness historically has originated on earth on the base of life, and for that reason one cannot draw such an analogy. This objection is based in practice on the assumption that the base of life is the only means

of origin of consciousness, but this is the very geocentricity about which Engels very unflatteringly spoke.

The human mind is a highly organized material system whose function is thinking. Can there exist another highly organized system which can lead to one and the same result? As strange as it may seem, M. N. Andryushchenko, having first declared that a machine cannot think, then diffidently agrees with the latter. "By means of the development of cybernetics the analogy between the activities of man and machines, from the point of view of results (our spacing -- Authors) will become more profound" (*Ibid*, page 106).

If one is speaking about highly organized material systems in which consciousness can originate, then in our opinion one can divide such systems into two classes. To the first class belong systems based on an organic form of motion, i.e., life. An example of such a system which is well known to us is consciousness on Earth. It seems to us that there is nothing strange, anti-scientific or contradictory to dialectical materialism in the assumption that a highly organized system which can lead to consciousness can be based in principle, not on the base of an organic form of material motion, but on other forms of motion different from that (for example, the physical form of motion). In our century, a century of breakthrough into the cosmos, we must allow for and be prepared to meet this variant.

It is possible that the complexity of organization of automatic machines will lead to the origination among us on the earth of a quality analogous to consciousness, not on the base of life but on the base of physical or other forms of material motion. It is not clear - what objective laws of nature and consciousness are contradicted by acknowledgment of such a possibility?

Besides these general objections against the fact that a machine can think, M. N. Andryushchenko lodges several private objections. Thus, she writes: "A machine has no aim, no needs, and no criteria" (*Ibid*, page 102).

What idea is inserted into the category of aim? It means that a human has an aim when, before he does something, he conceives in advance in his own mind what will be the result of his action (see for example, V. P. Tugarinov, Sootnosheniye kategorii dialekticheskogo materializma (Correlation of categories of Dialectical Materialism), 1956, pages 108-109). Characterizing the category of an aim, V. I. Lenin wrote: "As a matter of fact the aims of man are engendered by the objective world and presuppose him -- find him as a given, as something on hand. But, it seems to man that his goals are grasped outside of the world, are not dependent on the world ("freedom") (V. I. Lenin, Sochineniya (Works), Vol 38, page 180).

Several philosophers and physiologists (M. N. Andryushchenko is in this number), contending that a machine cannot and will not be able to think, that it has no aim, etc., introduce as an argument the fact that present-day machines do not think, have no aim. Actually, the machines of today function more or less according to a rigid program formulated by a human. They have no criteria, aim, etc., of their own.

In our view, we can conceive of a machine possessing an incomparably more complex structure than the ones existing in our time which will function according to some general algorithm formulated by man. As input data of this algorithm there will be, first, information about the external world received with the aid of some kind of artificial "organs of feeling," and, secondly, knowledge amassed by man and written in some formal machine language (see V. A. Uspensky, "On the Problem of Construction of a machine Language for an Information Machine, Problemy Kybernetiki, [Problems of Cybernetics], Edition 2, Fizmatgiz, Moscow, 1959). The algorithm will process (analyze) these initial data; the result of this will be an algorithm of instruction of the machine. The machine will construct various variants of this last algorithm and choose the best from these (it is possible with a probability estimate) from the point of view of some general criteria contained in the general algorithm. An example of such a criterion could be the storage by the machine of its own structure. The selection of the variant of the command algorithm might be considered a selection of a goal, but the command of the machine according to this algorithm as the realization of this goal. In such fashion this hypothetical machine will set a goal for itself in accordance with the criteria stored in it.

Not dwelling on other, and from our point of view, debatable propositions of the article, we will point out only the following: "The machine accumulates only that information which has a bearing on the problem decided on ... As far as man is concerned, in contrast to the machine, he formulates new problems and enlists for their solution material and knowledge accumulated through the solution of other problems, sometimes very different from the given one." (Filosofskiye Nauki No 3, 1959, page 104).

As was already pointed out above, knowledge accumulated by mankind can be stored in the machine's memory. It is not clear why a machine will not be able to preserve in its memory "material and knowledge accumulated through the solution of other problems, sometimes very different from the given one," and utilize them subsequently for the solution of new problems.

Thus, it seems to us that the idea of the possibility of creation of a machine possessing a quality analogous to consciousness, does not contradict the laws of dialectical materialism and natural science. The criticism in our literature of this point of view does not prove that such a contradiction exists.

REPLY TO COMRADES V. B. BORSHCHEV, V. V. IL'IN,
AND F. Z. ROKHLIN BY M. N. ANDRYUSHCHENKO

-USSR-

[Following is the translation of an article by M. N. Andryushchenko in Nauchnyye doklady vysshey shkoly, Filosofskiye nauki, No 4, Moscow, 1960, pages ~~106-108~~]

108-110.

The question of whether a machine can think is widely debated in our time, and in this regard the comrades who made the series of observations on my article, "Some Philosophical Problems of Cybernetics," are absolutely right. However, this question is not debatable from the point of view of dialectical materialism until we understand the system underlying the machine, the functioning of which is based on a conformity to the laws of inorganic matter. The position of the authors of these observations in this question is not expressed sufficiently accurately. In one case they speak of a property analogous to thinking and in the other, of machine's thinking. Criticizing the attitude of my article, V. B. Borshchev, F. Z. Rokhlin and V. V. Il'in write that a machine can think; at the same time they maintain, "that the idea of the possibility of creating a machine possessing a quality analogous to consciousness does not contradict the laws of dialectical materialism ..." But if the latter proposition is indisputable and we have no divergence of opinion on it, then we cannot agree with the first proposition. The attributing to a machine of psychic functions, including thinking, actually is not idealism but is an example of the vulgarization of materialism, is a type of physicism and a reduction of the highest form of material motion, if not to the mechanical, then to the physical. When speaking, for example, of a model of a conditioned reflex one must not identify it with the reflex. The essence of the reflex is that it guarantees the adaptability of the organisms to the conditions of existence, guarantees its survival. As a result, a biologically indifferent irritant becomes a signal biologically indispensable. A cybernetic toy can serve as an example of the external evidence of the functioning process of a conditioned reflex. Thus, one can "teach" the toy to by-pass an obstacle. It is not a reaction to a painful sensation such as in the case of a living organism. Here the reaction is not expedient from the point of view of the inner needs of the physical system itself. Man predetermined the character of the reaction. He could equally well have had the machine not by-pass the obstacle but continuously strike against it.

In one of his earliest works on cybernetics (see Ross Ashby, "Designs for a Brain," Electronic Engineering, Vol 20, No 250), Ross Ashby correctly noted that the presence of a feedback in a machine still does not solve the problem of the medelirovaniye [?] of the brain. The brain, for a biologist, is first of all a system which guarantees the organism's faculty of accommodation to new and changing conditions.

In insects, for example, the process of evolution eliminated the anomalous feedbacks, as a result of which they are splendidly adapted to the standard conditions of their surroundings. In mammals only an insignificant part of the feedback mechanisms is innate; the majority are formed on the base of unconditioned reflexes as a result of the animal's individual experience. In the kitten, says R. Ashby, the feedbacks are in a chaotic situation -- he can escape from the saucer and milk or draw closer, risking his life, to the pernicious corners of the room. The living experience of the animal gradually amends the character of the feedback mechanisms, making them more expedient from the point of view of the needs of the organism. Ashby was one of the first who proposed the construction of a machine which in contrast to ordinary electronic computers would be modelled exactly along this line of activity of the living organism. Here the question is of self-organizing systems where, in place of the rigid predestination in machines with a programmed control, an element of chance is included. A great flexibility is achieved by this. Sorting out the variants in compliance with the assigned criteria, the machine can find a variant not foreseen by the designer. So on the path of the designing of machines of a type such as "Perceptron," such a machine bears a stronger resemblance to a brain than to a digital computer. In our day these machines, in contrast to the digital machines which model a definite aspect of man's vented activity, model elementary psychic acts of the lower mammals. For this reason their use is still very limited.

There is no doubt that such a machine creates rich perspectives in the matter of modelling the vital activities of organisms. But here we are dealing with a model and not with "the same thing" which takes place in a living being while we remain in the confines of physical laws.

In his work "Materialism and Empiriocriticism," V. I. Lenin remarked that "In a clearly expressed form sensation is connected only with the higher forms of matter (organized matter) ..." (V. I. Lenin. Sochineniya, Vol 14, page 34). Can it be considered as chance that V. I. Lenin, in clarifying the understanding of "higher forms of matter," speaks of organic form of matter? Can it be considered as chance, having our place only on the confines of Earth, that all forms of the psychic, beginning with sensation, are connected with the organic form of material motion? Can one agree with the opinion of the authors and consider as possible the ap-

pearance of higher forms of psychic activity on a base of physical laws?

The progressive development of forms of material motion are characterized more and more by delicate dynamic equilibrium, internally -- the atom, internally and externally -- the organism. Progress within the limits of organic matter are characterized by an ever-growing activity which is independent of the oscillations of the immediate surroundings. The mobility of the animal allows him to search out the necessary surroundings for habitation while man creates these. Temperature exerts considerable influence on the flow of processes. In the organism it is maintained at one, indispensable level. The natural laws of biology limit the action of physical natural laws, counteracting, for example, the equalization of the temperatures of the organism and its surroundings. The well known independence of the living organism from its surroundings is conditioned by its ability to derive energy, putting it, as it were, in a constrained condition. The interchange of substance with environment is the condition of its existence as a living organism. The cessation of this interchange even for a short period will lead to irreversible reactions, to the disintegration of the organism. On the basis of interchange of a substance, of a form of reciprocal action with its environment which is inherent only in living things are formed functions, becoming more and more complicating, which guarantee it reciprocal action -- irritability, sensitivity -- all forms of the psychical. At the highest stage of development of the interaction, based not only on organic but also social forms of material motion, theoretical thinking is formed and science springs up -- essential conditions for the vital activity of society as a whole. For this reason thinking necessarily assumes an intrinsic need to establish ever more complicated communications with the environment, including the social.

It seems to us that the attempt by I. A. Polyetaev in his book, Signal, was frivolous in identifying the organic interaction of substance with what is theoretically a possible interaction accomplished by substituting out-of-operation units and electronic tubes. In his time, Engels correctly explained that the interaction of matter, as such, also takes place in inanimate nature. Here we have in mind the interaction which constitutes an absorption of matter whose chemical composition changes, and of matter which is assimilated by the organism the remains of which are excreted together with the products of the decomposition of the organism itself which arise during the life process.

Only on the basis of interaction of substances, peculiar to the animate organism, are the needs of the organism formulated, the ties with environment increased and the transition from adaptive reactions to human, creative activity guaranteed.

Expansion in the means for an interchange of information underlying this problem is, like the psychical, a derived, subordi-

nate aspect. The hypothetical eurygasters about which L. Teplov writes in a book, Ocherki o Kibernetikye, (L. Teplov, Ocherki o kibernetikye [Essays on Cybernetics], Publishing House "Moscow Worker," 1959) by their activity realize, at first glance, the intrinsic needs of the system. The accumulators on which their mobility depends are charged directly by the sun's rays. They shift as if deliberately seeking the sunny side. When the accumulators are charged, the eurygasters begin to shift to the shady side as if attempting to escape the recharging. However, if such a surygaster is isolated from the influence of the environment, it retains its structure for any length of time. Having been charged, it will again begin to function. Thus, in this case as contrasted with the animate the cessation of functioning does not indicate the disintegration of the structure; the active interaction with the environment is not an expression of an intrinsic necessity of its existence. At an industrial exhibition we can even see non-functioning electronic computers. Isolation from extrinsic environment is the best guarantee of their safekeeping. Isolation of the living organism from interaction with the environment inevitably will lead to its death, to irreversible reactions, to disintegration. For this reason even an elementary organism is immeasurably greater than "Perceptron," since the stimuli of its evolution and the perfection of its reactions lie in the needs of the organic form of material motion itself and do not act through some extrinsic goal alien to this form. The needs of each specific structure are a concrete definition of a more general need inherent in the organic world -- the need to exchange substance with environment. Not denying the natural origin of goals, Marxism, in contrast to teleology, does not consider that nature as a whole has goals.

My opponents, basing their assertion on the fact that, by complicating the structure of the machine, we can arrive at the construction of a thinking machine refer to the law of transition from quantitative to qualitative changes. However, they don't take into account the fact that not every quantitative change leads to radical qualitative changes. For this reason we will not leave the confines of the physical form of material motion and its potentialities by a mere increase in the quantity of electronic tubes and block-diagrams.

This path along which cybernetics goes in the creation of machines is not connected with any higher form of material motion than the physical. The ambiguity of the terms "complexity" and "complication," which are used by the authors of the observations, lies in the fact that one can greatly complicate construction but still remain within the limits of the lower forms of material motion. When we speak of a higher form of matter of which tinkering is a product, then we have in mind not complexity of structure within the confines of the physical form of matter but the transition to higher forms of material motion including all the preceding growth

steps in quality of subordinate moment.

In order to be dialectical materialist it is little to admit that there is no perfect, unless material, bearer. By this admission we still have not risen above the understanding of the present question by old materialists. Dialectical-materialist understanding means the admission of the fact that thinking is a product of highly organized matter in the sense which we spoke of above.

The authors of the observations attribute to machines a characteristic which, according to them, can be admitted as thinking. Those signs, for instance, of the ability to process information according to some algorithm, etc., happen in the sphere of higher forms of matter (we meet them everywhere), are by no means an indication of thinking systems. Even an extremely high stage of development of interaction with environment on the level of the organic form of material motion is not always a condition for the creation of thinking. It is noteworthy that the bee, when building honey combs, resolves in practice a problem solved by mathematicians only in the 19th Century, the extremum problem: how to get the largest size cell with the smallest expenditure of construction material. The mathematicians received the same answer as the bee: the cell must be a hexahedron. In other words, the bee gives an optimal variant of the solution. On these grounds, however, no one in our time will begin to maintain that bees think or that they are more clever than man, but here in regard to machines which in the realization of formal relationships stand immeasurably lower than bees there is serious talk about the possibility of creating in them functions identical to thinking.

We will recall the statement of Marx concerning the fundamental distinction between the activity of man and the bee, despite the similarity and sometimes the superiority of the latter from the point of view of results. This statement also proves that similarity of result does not signify the identity of the processes previous to it; one and the same consequence can have different reasons.

In the first volume of Kapital, K. Marx wrote the following: "The spider performs an operation reminiscent of a weaver, and the bee puts many human architects to shame with the construction of his waxen cell. But the worst architect is distinguished from the best bee from the start due to the fact that the bee, before he builds his cell from wax, has already constructed it in his head. At the end of the labor process a result is received, which was to be found in the performance of the worker at the beginning of the process -- i.e. ideally. The worker distinguishes himself from the bee not only in the fact that he changes the form of that which is given by nature in that which nature provides he, at the same time, realizes his own creative and which like a law specifies the mode and character of his action and to which he must subordinate his will" (K. Marx. Kapital, Vol 1, Gospolitizdat (State Political

Publishing House), 1951, page 185). And a machine can put man to shame from the point of view of the practical realization of formal space-time relationships, in speed of execution of mathematical operations and in finding an optimal variant. We see how imprudent it is to conclude, on the basis of the example of the bees, that machines think or reflect.

The road to design of a structure which would discover fundamental psychical phenomena is one of organic synthesis and chemical transformations. And on this human road there will undoubtedly be great victories. As far as direct, artificial creation of thinking "essence" from inorganic material is concerned, contemporary science has no facts which speak in favor of such a view.